REMARKS

By the present amendment and response, claims 93 and 105 have been amended to overcome the Examiner's objections. Claims 93-117 are pending in the present RCE application. Reconsideration and allowance of pending claims 93-117 in view of the above amended claims and the following remarks are requested.

The Examiner has rejected claims 93-117 under 35 USC §103(a) as being unpatentable over U.S. patent number 5,792,706 to Michael et al. ("Michael") in view of U.S. patent number 6,040,248 to Chen et al. ("Chen"). For the reasons discussed below, Applicant respectfully submits that the present invention, as defined by amended independent claims 93 and 105, is patentably distinguishable over Michael and Chen.

The present invention, as defined by amended independent claim 93, teaches, among other things, "a trench situated between a first and a second interconnect line," and "forming a first air gap, a second air gap, and a support pillar in said first hard mask and said first insulating layer, said support pillar being situated between said first air gap and said second air gap, said support pillar, said first air gap, and said second air gap being situated in said trench, said support pillar being in contact with said first interconnect line." As disclosed in the present application, by forming a support pillar between first and second air gaps such that the support pillar is in contact with a first interconnect line, the support pillar increases the mechanical strength and thermal conductivity of the first interconnect line. Also, by appropriately controlling the size and shape of the first and second air gaps formed in the hard mask, the size and shape of the support pillar formed

between the first and second air gaps in the first insulating layer can be controlled to achieve a desired increase in mechanical strength and thermal conductivity of the first interconnect line.

In addition, as disclosed in the present application, the hard mask is utilized during etch and clean steps in transferring an air gap pattern to the first insulating layer to precisely determine the location of the first and second air gaps and, consequently, precisely determine the location of the support pillar. Thus, the present invention advantageously achieves a flexible interconnect structure that includes first and second air gaps to provide reduced inter-layer and/or intra-layer parasitic capacitance and a support pillar having an appropriate size and shape to increase the mechanical strength and thermal conductivity of an interconnect line, which is in contact with the support pillar.

Moreover, amended independent claim 105 teaches, among other things, "a trench situated between a first and a second interconnect line," and "forming a first air gap, a second air gap, and a support pillar in said first hard mask, said second insulating layer, and said first insulating layer, said support pillar being situated between said first air gap and said second air gap, said support pillar, said first air gap, and said second air gap being situated in said trench, said support pillar being in contact with said first interconnect line." The present invention, as defined by amended independent claim 105, also includes the advantages of amended independent claim 93 discussed above. Additionally, as disclosed in the present application, by utilizing first and second insulating layers, the present invention, as defined by amended independent claim 105,

achieves a flexible interconnect structure that can be advantageously adapted to satisfy the requirements of specific applications by appropriately selecting the respective composition and deposition process of the first and the second insulating layer.

In contrast to the present invention as defined by amended independent claims 93 and 105, Michael does not teach, disclose, or suggest depositing a first hard mask on a first insulating layer and forming first and second air gaps and a support pillar in the first hard mask and first insulating layer, where the support pillar is situated between the first and second air gaps in a trench, and where the support pillar is in contact with a first interconnect line. Michael specifically discloses removing portions of first dielectric 20 to form air gap trenches 26 in first dielectric 20, where air gap trenches 26 are preferably formed at spaced intervals across first dielectric 20. See, for example, column 6, lines 12-15 and Figures 5-7 of Michael. In one embodiment, Michael discloses placing air gap trenches 26 indiscriminately with respect to first interconnect lines 11. See, for example, column 6, lines 33-42 and Figure 6 of Michael. However, Michael does not teach, disclose, or suggest forming a support pillar between air gap trenches 26, where the support pillar is in contact with an interconnect line. In fact, Michael does not even mention a support pillar or similar structure that is formed between air gaps to increase the mechanical strength and thermal conductivity of an interconnect line.

Furthermore, by placing air gap trenches 26 indiscriminately with respect to first interconnect lines 11, Michael teaches away from intentionally forming a support pillar between adjacent air gap trenches and in contact with an interconnect line such that the

mechanical strength and thermal conductivity of the interconnect line is increased. Also, Michael does not teach, disclose, or suggest forming a hard mask over first dielectric 20 or utilizing a low-k dielectric for first dielectric 20.

In contrast to the present invention as defined by amended independent claims 93 and 105, Chen does not teach, disclose, or suggest depositing a first hard mask on a first insulating layer and forming first and second air gaps and a support pillar in the first hard mask and first insulating layer, where the support pillar is situated between the first and second air gaps in a trench, and where the support pillar is in contact with a first interconnect line. Chen specifically discloses utilizing photoresist pattern 28 to form a silicon oxide hardmask, which is then utilized to etch a contact opening in organic layer 24. See, for example, Chen, column 4, lines 6-9. However, Chen does not teach, disclose, or suggest forming air gaps and a support pillar in the hard mask and organic layer 24 and sealing the air gaps.

For the foregoing reasons, Applicant respectfully submits that the present invention, as defined by amended independent claims 93 and 105, is not suggested, disclosed, or taught by Michael and Chen. As discussed above, amended independent claims 93 and 105 are patentably distinguishable over Michael and Chen and, as such, claims 94-104 depending from amended independent claim 93 and claims 106-117 depending from amended independent claim 105 are, *a fortiori*, also patentably distinguishable over Michael and Chen for at least the reasons presented above and also for additional limitations contained in each dependent claim.

Based on the foregoing reasons, the present invention, as defined by amended independent claims 93 and 105 and claims depending therefrom, is patentably distinguishable over the art cited by the Examiner. Thus, claims 93-117 pending in the present application are patentably distinguishable over the art cited by the Examiner. As such, and for all the foregoing reasons, an early allowance of claims 93-117 pending in the present application is respectfully requested.

Respectfully Submitted,
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Date: MF 7/1/03

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Claims:

Claims 93 and 105 have been amended as follows:

93. (Once Amended) A method of manufacturing an interconnect, said method comprising steps of:

forming a first patterned layer of conductive material, said first patterned layer having [at least one] a trench situated between a first and a second interconnect line;

depositing a first insulating layer over said first patterned layer, said first insulating layer filling said [at least one] trench;

depositing a first hard mask on said first insulating layer;

forming a first air gap, a second air gap, and a support pillar in said first hard mask and said first insulating layer, said support pillar being situated between said first air gap and said second air gap, said support pillar, said first air gap, and said second air gap being situated in said trench, said support pillar being in contact with said first interconnect line;

depositing a sealing layer over said first hard mask to seal said first air gap and said second air gap.

105. (Once Amended) A method of manufacturing an interconnect, said method comprising steps of:

forming a first patterned layer of conductive material, said first patterned layer having [at least one] a trench situated between a first and a second interconnect line;

depositing a first insulating layer over said first patterned layer, said first insulating layer filling said [at least one] trench;

depositing a second insulating layer over said first insulating layer;

depositing a first hard mask on said second insulating layer;

forming a first air gap, a second air gap, and a support pillar in said first hard mask, said second insulating layer, and said first insulating layer, said support pillar being situated between said first air gap and said second air gap, said support pillar, said first air gap, and said second air gap being situated in said trench, said support pillar being in contact with said first interconnect line;

depositing a sealing layer over said first hard mask to seal said first air gap and said second air gap.